ELECTRONIC ANNEX

Below is a version of the Matlab code used to model the distribution of Fe and Fe isotopes in this manuscript:

```
% A basic model for determining the distribution of Fe and Fe isotopes in
% the San Pedro Basin.

K = 1;                        % Vertical diffusivity, in units of cm^2/sec.
FeTop = 4.08;                 % Dissolved Fe concentration above the sill depth.
Also, Fe concentration for waters sinking into the bottom of the San Pedro
Basin, in units of nM.
dFeTop = 1.44;                % Dissolved Fe isotope ratio above the sill depth.
Also, Fe isotope ratio for waters sinking into the bottom of the San Pedro
Basin, in units of permil d56Fe compared to IRMM-014.

FSed = 0.32;                   % The flux of dissolved Fe from one square meter
of sediments, in units of micromoles m^-2 d^-1. For a 1 m box height, this is
equivalent to units of nM d^-1.
kppt = 0.0018;                % First order rate constant for Fe precipitation,
in units of d^-1.
d56Fesed = -2.45;             % The Fe isotope ratio of dissolved the Fe flux out
of the sediments, in units of permil d56Fe compared to IRMM-014.
Dd56Feppt = -0.87;            % The isotope effect for Fe precipitation in the
water column, in units of permil d56Fe.

depth = (750:1:900)';         % Specifies the depth for each layer in the model.

K = K* 8.64;                  % Converts vertical diffusivity from units of
cm^2/sec into m^2/day.
w = K/47;                     % Sets the upwelling velocity based on a scaling
height of 47 m, in units of m/d.
Diff = K;                     % The proportion of Fe which mixes across the top
or bottom of each box at each timestep, normalized here for a 1 m box height
and given in units of d^-1.
Upwell = w;                   % The proportion of Fe which upwells from a box
below to a box above at each timestep, normalized here for a 1 m box height and
given in units of d^-1.

% szvz is the surface area of sediments at a given depth divided by the
% total area of the basin at that depth.
szvz = [0.0068  0.0051  0.006   0.0056  0.0055  0.0062  0.0055  0.0059  0.0067
0.0081  0.0071  0.0063  0.0063  0.006   0.0056  0.0062  0.0069  0.0063  0.0061
0.0083  0.0069  0.0075  0.0063  0.0087  0.0087  0.0095  0.0078  0.008   0.0071
0.0069  0.0068  0.0058  0.0051  0.0058  0.0061  0.0052  0.0049  0.0051  0.0059
0.0058  0.0054  0.0074  0.0063  0.0066  0.006   0.0084  0.0088  0.0077  0.0093
0.0086  0.008   0.0095  0.0094  0.0083  0.0091  0.0103  0.0102  0.0094  0.0094
0.0091  0.0121  0.0135  0.0137  0.0123  0.0103  0.0112  0.0097  0.0103  0.0101
0.0113  0.0092  0.0099  0.0096  0.0106  0.0126  0.0133  0.0126  0.0118  0.0146
0.0119  0.0129  0.0145  0.0117  0.0104  0.011   0.0112  0.0129  0.0136  0.0132
0.0143  0.012   0.0125  0.0125  0.015   0.0135  0.0132  0.0164  0.0114  0.0114
0.0098  0.0101  0.0099  0.0091  0.0126  0.0154  0.0107  0.0129  0.0147  0.0134
0.0123  0.0137  0.0138  0.019   0.017   0.0152  0.0155  0.0159  0.0134  0.0155
0.0135  0.0169  0.0143  0.0155  0.0188  0.0168  0.0236  0.0177  0.017   0.0192
0.0187  0.0218  0.0234  0.0243  0.0333  0.0357  0.0346  0.0404  0.0495  0.0739
0.1039  0.0742  0.0896  0.1267  0.1542  0.1509  0.1599  0.199   0.2364  0.2667
0.4786  1]';
Fz = szvz * FSed;             % The increase in Fe concentration due to
sedimentary Fe flux, in units of nM/d.
```

```
% The code below solves the set of linear algebra equations describing the
% steady state concentration profile of Fe-56.

Fz56 = Fz * 0.9172;         % The flux of Fe-56 from the sediments.
FeTop56 = FeTop * 0.9172;      % The concentration of Fe-56 above the top box.

matrixA = zeros(151,151);

for i = 2:1:150;
    matrixA(i,i-1) = Diff;                      % Input of Fe to each layer by
diffusive mixing from above.
    matrixA(i,i) = -Upwell-2*Diff-kppt;         % Loss of Fe by upwelling,
diffusive mixing, and precipitation.
    matrixA(i,i+1) = Diff+Upwell;               % Input of Fe by diffusive
mixing and upwelling from below.
end

matrixb = -Fz56;                                % Input of Fe from sedimentary
flux.

matrixA(1,1) = -Upwell-2*Diff-kppt;
matrixA(1,2) = Diff+Upwell;
matrixb(1) = matrixb(1) - Diff * FeTop56;       % Sets the upper boundary
condition so that the Fe concentration above the profile is always equal to
FeTop.

matrixA(151,150) = Diff;
matrixA(151,151) = -Upwell-Diff-kppt;
matrixb(151) = matrixb(151) - Upwell* FeTop56;  % Sets the lower boundary
condition such that inflowing water to the bottom layer has the Fe
concnetration equal to FeTop.

Fe56 = matrixA\matrixb;

% The code below solves the set of linear algebra equations describing the
% steady state concentration profile of Fe-54.

kppt54 = kppt*(1-Dd56Feppt/1000);
Fz54 = Fz * 0.058 * (1-d56Fesed/1000);
FeTop54 = FeTop * 0.058 * (dFeTop/1000+1);

matrixA = zeros(151,151);
matrixA(1,1) = -Upwell-2*Diff-kppt54;
matrixA(1,2) = Diff+Upwell;
matrixA(151,150) = Diff;
matrixA(151,151) = -Upwell-Diff-kppt54;
for i = 2:1:150;
    matrixA(i,i-1) = Diff;
    matrixA(i,i) = -Upwell-2*Diff-kppt54;
    matrixA(i,i+1) = Diff+Upwell;
end
matrixb = -Fz54;
matrixb(1) = matrixb(1) - Diff * FeTop54;
matrixb(151) = matrixb(151) - Upwell * FeTop54;

Fe54 = matrixA\matrixb;

dFe = ((Fe56./Fe54)/(.9172/.058)-1)*1000;       % Calculates d56Fe.
Fe57 = Fe56.*(0.022*((3/2)*dFe/1000+1));        % Calculates the Fe-57
concentration based on natural abundances and the d56Fe.
Fe58 = Fe56.*(0.0028*((4/2)*dFe/1000+1));       % Calculates the Fe-58
concentration based on natural abundances and the d56Fe.
Fe = Fe54+Fe56+Fe57+Fe58;
```

```
SPOTdepth = [751 776 801 895];
SPOTFe = [4.08;4.30;4.85;7.33];
SPOTdFe = [-1.44;-1.45;-1.55;-1.82];

a = [Fe(1);Fe(27);Fe(52);Fe(146)];
diff = a - SPOTFe(1:4);
XFe = sum((diff.*diff)./0.01)/1;                % Calculates chi-squared for
the difference between model and observed Fe concentrations.

b = [dFe(1);dFe(27);dFe(52);dFe(146)];
ddiff = b - SPOTdFe;
XdFe = sum((ddiff.*ddiff)./0.0009)/1;           % Calculates chi-squared for
the difference between model and observed Fe concentrations.

figure(1)
set(1,'color','w')
set(1, 'PaperUnits', 'centimeters');
set(1, 'PaperSize', [16 16]);
set(1, 'PaperPosition', [1 1 15 15]);
clf
set (1,'position',[400 500 400 300]);

subplot(1,2,1)
plot(Fe,depth,'-k','Linewidth',2);
hold on;
plot(SPOTFe,SPOTdepth,'o','Color', 'k',
'markersize',7,'MarkerEdgeColor','k','MarkerFaceColor','k');
hold on;
set(gca,'Ydir','reverse','Xlim',[0 12],'Ylim',[700
900],'Xtick',[0:2:12],'Fontsize',16)
xlabel('Fe (nM)','fontsize',14)
ylabel('depth (m)','fontsize',14)

subplot(1,2,2)
plot(dFe,depth,'-k','Linewidth',2);
hold on;
plot(SPOTdFe,SPOTdepth,'o','Color',
'k','markersize',7,'MarkerEdgeColor','k','MarkerFaceColor','k');
set(gca,'Ydir','reverse','Ylim',[700 900],'Ytick',[],'Fontsize',16);
set(gca,'Ydir','reverse','Xlim',[-2 -1],'Xtick',[-2:.25:-1],'Ylim',[700
900],'Ytick',[],'Fontsize',16);
xlabel('\delta^{56}Fe ({\fontsize{12}%}{\fontsize{8}o})','fontsize',14
```